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A SERIES OF TEXTBOOKS FOR PERSONS ENGAGED IN THE ENGINEERING PROFESSIONS AND TRADES OR FOR THOSE WHO DESIRE INFORMATION CONCERNING THEM. FULLY ILLUSTRATED AND CONTAINING NUMEROUS PRACTICAL EXAMPLES AND THEIR SOLUTIONS

MANUFACTURE OF SUGAR
COTTONSEED OIL AND PRODUCTS
PETROLEUM AND PRODUCTS
WATER SOFTENING

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In speaking of the utilization of the light products of Russian petroleum, Crew says: "The light oils evaporated during the first distillation are allowed in most instances to run into the sea, but lately certain refiners have commenced to work them into gasoline and benzine, and, though the market for these products in Russia is limited, they yield a reasonable profit." This same thing can be said of the American light oils prior to about the year 1885. Then the naphtha was run into streams or used as fuel under the stills as a waste product.

Since it was first refined it has gradually worked its way to the favor of the public until, during the summer of 1898, all grades, from the very lightest to the heaviest, commanded a higher price than the best grade of kerosene. From being a by-product in the petroleum refinery, it has taken first place. Use has been found for it for cooking and heating, for whatever purpose gas could be used, and, consequently, it has brought comfort to people of the rural districts.

THE PARAFFIN INDUSTRY

40. Introductory.—Notwithstanding the fact that paraffin had been known for a long time, its manufacture on a large scale is of a comparatively recent date. It was known to exist as ozokerite, or earth wax, in Europe and various parts of America, but the discovery that it is a product of distillation of several organic bodies belongs to Karl Reichenbach, who gave it the name paraffin, from *parum* and *affinis*, because it appeared to be wholly destitute of chemical affinity. Its commercial value is based on the work of Seligue, of France, who manufactured it from bituminous shale. The production from this source has grown to enormous proportions in Europe and had taken a fair step in America when the more abundant and cheaper crude material, petroleum, took its place. In this country it is now entirely obtained as a by-product in the petroleum distillation, and this, like many of the other by-products of

petroleum, has grown to such proportions as to become almost the principal product in certain petroleum distillations. It does not possess a constant composition; but, like all the other products of petroleum, it is a mixture of a number of hydrocarbon compounds.

In treating the subject from the standpoint of the refiner, the preparation of lubricating oils and the manufacture of paraffin wax run so closely together that in some points at least they touch, and must be treated as if they belonged to one subject. The manufacture of either or both begins with the distillation of the residuum coming from the illuminating oil distillation or the crystallization of the wax oils coming from the lubricating-stock distillation.

41. Distillation of Oil Residues.—The mineral tar or residuum is transferred after becoming entirely cold, or is reheated and then transferred into stills of about 300-barrel capacity. In the largest works much larger stills are also used. These stills have especially heavy steel bottoms and good internal bracing. The outlet, or vapor, line is large and is divided, by means of a U-shaped arrangement of the lines at the condenser, into two parts, as shown in Fig. 7. The one line *a* remains on a level with the vapor line, passes around the condenser, forming an air condenser of from 80 to 100 feet, and finally enters the condenser box and passes to the receiving house through a separate line;

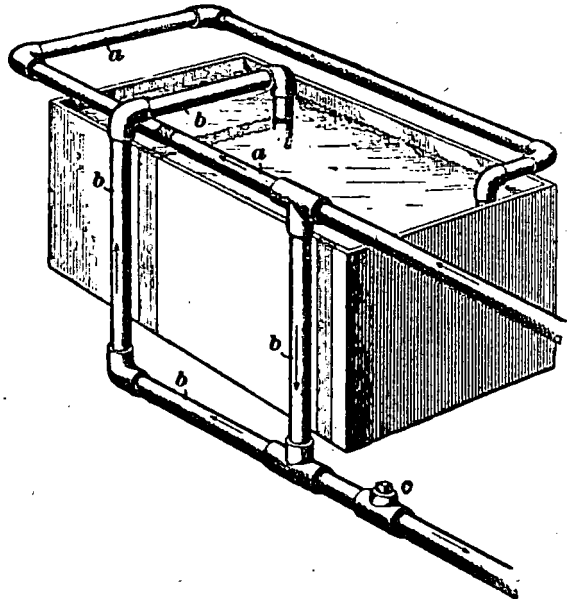

FIG. 7

the other line *b* makes a drop of about 5 feet from a T in the vapor line, and forming a U, rises again, enters the water box, traverses it several times, and thence passes to the receiving house. Thus, the still has two separate lines that carry off distillate at the same time. The water condenser is small and not kept too cool.

The still is heated gradually. If the tar has been chilled it begins by reporting with a bumping sound; this will increase in rapidity, but should not increase in force; if it does, it is a sign of moisture. A regular humming and crackling sound indicates boiling and no danger from moisture. This boiling may require 3 or 4 hours, according to the condition of the tar used. The fires are now crowded to their utmost in order to distil without cracking. The first distillates coming from both air and water condenser lines are run into a separate tank, to be rerun or used as a heavy gas oil. As soon as the oil coming from the water condenser line is clear and usually about 36° Baumé, it is turned into the paraffin distillate tank. The air line will run oil which is quite light and contains but little wax, and continues to run to the heavy gas oil, until near the end of the run, when it is found to contain wax and is turned into the same tank as the stream from *b*. Thus the stillman is enabled to separate the light oils from the heavy oils without refractionation.

The paraffin distillate is made in one long cut. The only point to be observed is to avoid too much color. The bottom of the still assumes a cherry-red color and the distillate becomes heavier and more waxy until the latter end of the run, when it is almost a pure wax. This is known as the *wax tailings*, and is permitted to run directly to a separate tank, by opening the stop-cock *c* on the vapor line. The whole charge of 240 barrels may be run off in from 8 to 12 hours. Since the still is run dry in order to get all oil and make a good coke, the stillman must be experienced in knowing just when to shut it down and not overtax the bottom, which with care should make from thirty to forty runs. The coke from the tar still is a valuable by-product, being

used in the manufacture of electric supplies, artist's carbons, etc.

42. The other source of paraffin in a petroleum paraffin works, as already mentioned, is the wax distillate coming from the steam distillation in the manufacture of lubricating stocks. This wax oil is again placed in the still and rerun without the use of steam in the bottom of the still. This is what is known as the crystallization of the wax oil. Much has been said for and against the idea of paraffin existing in the crude oil in an amorphous state. However this may be, it is a known fact to the refiner that unless the oil be distilled at a high temperature the paraffin will have a vaseline consistency and stick to the disks and filter-press plates; whereas the crystallized wax oils press easily and the wax comes off in hard and firm cakes. The cut from the crystallization of the wax oil is the same as the first making of a distillate of 30° to 34° Baumé. This, however, varies, according to the peculiar views of the refiner and the wants of his customers.

43. Treatment of Paraffin and Wax Distillates.—The paraffin and wax distillates are pumped to the paraffin agitator (see lubricating agitator described later). This is constructed on the same general principles as the other agitators described with the exception of a special arrangement for heating its contents and keeping the dense and easily congealed oil in a liquid condition. No more heat should be employed than is actually necessary to keep the contents in a fluid state and the paraffin entirely melted. The same general principles of chemical treatment followed in the case of the illuminating oil are observed here. The action of the acid on the oil is very energetic and is accompanied by the disengagement of large volumes of vapors containing sulphur dioxide. For drawing off the heavy acid sludge coming from this treatment, exit pipes and stopcocks of large internal diameter are required. The sludge on standing becomes quite solid, and on being neutralized

with lime forms an asphaltum which is excellent for roofing and light paving.

The acid treatment is followed by the usual water and alkali wash. This treatment being complete, the oil is transferred to a shallow tank provided with a steam coil, in order to keep the wax from congealing, and to permit the settlement of the water. This purifies the paraffin, removing all coke and petroleum acids, which are ruinous to the canvas of the filter presses.

44. Chilling.—The oil is next transferred to another shallow tank, where it is subjected to the chilling process. This was formerly carried out by means of a freezing mixture, composed of broken ice and salt placed about the cask containing the oil, similar to the arrangements in an ice-cream freezer. At present, ammonia ice machines are employed entirely for this purpose.

One of the methods in applying the cold produced by the evaporation of the liquid ammonia is to lead the ammonia pipes, together with a set of pipes to convey the oil to the filter press, through a vat containing a solution of calcium chloride. The evaporation of the liquid ammonia in the pipes, brought about by means of a vacuum pump, chills the solution of calcium chloride, which in turn cools the oil being pumped through the other coil, and thus causes the paraffin to crystallize. The wax oil may enter the vat at 80° to 90° F. and leave it at 10° or 15° F.

45. Pressing.—The first pressing is usually carried out at about 40° F. in a filter press (see Fig. 8). The chilled paraffin oil is placed in canvas bags and arranged in the filter press between perforated iron disks. The whole is subjected to a gradually increasing pressure, which forces out the liquid oil and leaves the solid paraffin behind. Unless this operation be skilfully conducted, enough crystallized paraffin may be forced through the canvas to interfere materially with the cold test of the oil.

These cakes of paraffin are melted and the fluid paraffin filtered through bone-black filters to remove the coloring

matter contained in it. It is again chilled and placed in the hydraulic filter press, which is similar to the first, in which it is subjected to a much greater pressure at a higher temperature than before. It is pressed for from 5 to 8 hours at 70° F. and at a pressure of 300 pounds to the square inch. This produces a wax melting at from 117° to about 120° F. The melting point varies somewhat with the gravity of the oil brought to the presses. The cakes thus formed are removed and ground up into small scales. This scale when not treated with bone black is what is known as *crude scale*, and much of it is sold in this form to be worked up for special purposes.

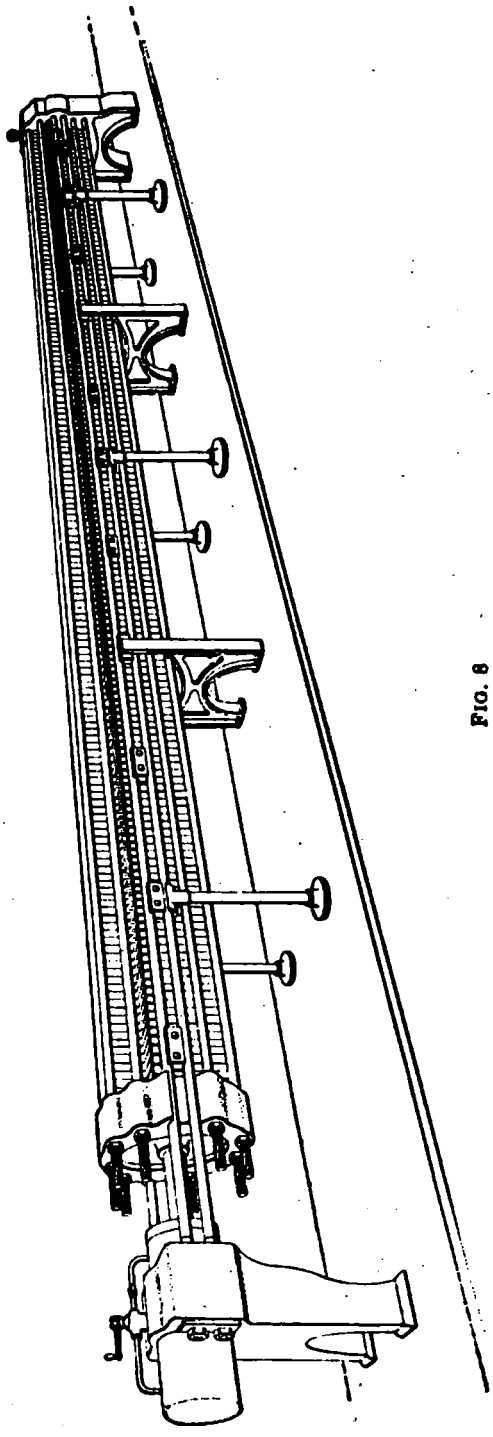

FIG. 8

The refiner making refined wax grinds the crude scale with benzine and by gently heating dissolves the wax. This is again cooled and subjected to hydraulic pressure. This is known as the *recrystallizing process*. The paraffin thus obtained is in large

crystals, perfectly white and transparent, and has a somewhat higher melting point. Where there are no particular melting-point requirements this wax is used exclusively. In order to meet the requirements of higher melting points and perfect freedom from oil, the paraffin is put through the *sweating process.*

46. Sweating Process. — The recrystallized wax is melted and run into shallow pans 3 inches deep, 4 to 5 inches wide, and about 24 inches long. It is chilled and these cakes placed in a small room surrounded by steam coils. The cakes are placed on racks having perforated bottoms, underneath which are tin troughs leading to a common receptacle. This room is heated to the temperature of the melting point that the wax is required to have and kept at that temperature for about 12 hours, when all the oil and low-melting paraffin will have dripped out of the cakes, which come out perfectly honeycombed, but of the desired melting point. The American paraffin is usually sold at the melting points of 125°, 128°, and 135° F., known as C, B, and A paraffin, respectively.

Since paraffin has been produced in such large quantities from the American petroleum, the large manufacturers have made especial efforts to introduce it into general use. By their persistent efforts in informing the public and placing it on the market in convenient forms, it is steadily but surely becoming a household article of inestimable value. The paraffin candle has completely superseded all other forms of illumination along this line. It is also taking the place of sealing wax in the preservation of jellies and fruits.

THE PRODUCTION AND MANUFACTURE OF LUBRICATING OILS

47. Introductory. — The pecuniary and beneficial advantages accruing to modern civilization from the introduction of the heavy products of petroleum for the lubrication of machinery are hardly second to those resulting from the introduction of the cheap and beautiful light furnished